Knowledge Representation & Authoring in Adaptive Education

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Overview

Ideal learning?

Ideal authoring of learning resources?

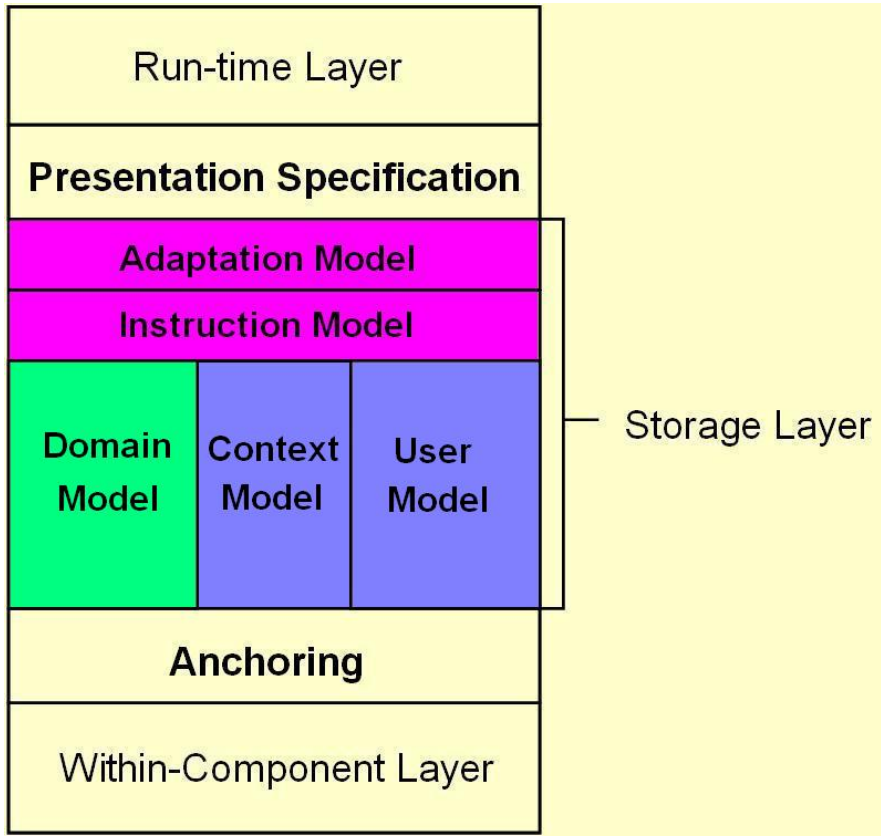
Ideal representation of learning resources?

Issue: specification of concrete learning resource instances is usually context dependent and does not support reusability very well

Structure:

- Model of Adaptive Learning System
- Representation of Learning Resources – reusability
- Summary and Conclusion

Model of Adaptive Learning System



Representations of Learning Resources

Declarative knowledge: domain, user, context models
Procedural knowledge: pedagogical, adaptation models

Existing approaches:

- **Informal scripts**
- **System encoding**
- **Elicited knowledge**
- **Standards**
- **Ontologies**
- **Your approach?**

Informal Scripts

Alfred Bork – **tutorial learning** paradigm – based on Socratic dialog – frequent questions, free-form answers

Adaptive learning units – designed by a **team** of people with different competencies, including domain experts and teachers

Overall design – a list of modules to develop
Detailed design – sensitive to individual students by generating diagnostic questions and providing suitable feedback

Designers sketch informal scripts – design logic and messages for the learner
Programmers – programming logic, screen design, suitable media

Knowledge is represented **implicitly** in the design scripts – **not reusable**

Freedom of authors, complicated authoring process

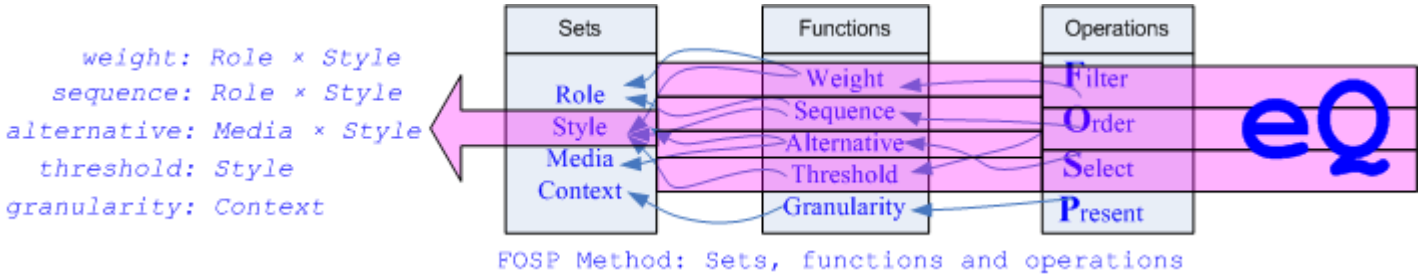
System Encoding

Example – **WINDS:**
- teachers specified pedagogical requirements
- programmers implemented them in ALE
- **procedural knowledge encoded** in the system

Simplified authoring – authors without programming skills can create adaptive courses

Fixed representation of procedural knowledge

Elicited Knowledge



Separation of learning design and adaptation strategies from concrete materials & contexts

Reusability of procedural knowledge

To achieve a critical mass of its instances a specification language has to be **standardized**

- lowest level: *direct adaptation techniques/ rules*
  - adaptive navigation support & adaptive presentation
  - implem.: AHA!; expressed in AHAM syntax
  - techniques usually based on threshold computations of variable-value pairs.

Adaptation Assembly language

- medium level: *adaptation language*
  - more goal / domain-oriented adaptation techniques: based on a higher level language that embraces primitive
  - low level adaptation techniques (wrapper)
  - new techniques: adaptation language

Adaptation Programming language

- high level: *adaptation strategies*
  - wrapping layers above
  - goal-oriented

Adaptation Function calls

Standards

IMS Simple Sequencing: provides learning material tailored to the learner's current context, but makes no distinction between users
IMS Learning Design: explicit notation to enable **interoperability** on the level of systems; **personalization** – conditions, DIV layers, hide-visible properties

Towle & Halm: IMS LD provides a way to implement **simple adaptive learning strategies**, but not complex forms of adaptive learning, like multiple rules interactions or enforced ordering

aLFanet: **learning standards are not harmonized** to work with each other and available **tools are too complex** for non-specialized authors

ALD: IMS LD can be used to model and annotate adaptive learning design, but designing **more complex adaptivity** behavior might be **not too easy**

Zarraonandia: **reusability** of learning design – runtime adaptation to actual context

Ontologies

Challenge: creation and use of ontologies to represent various types of **knowledge** relevant for personalized adaptive learning

Stojanović et al., 2001: **lack of formal semantics** as major obstacle to interoperability of e-learning systems –> ontologies

Henze et al., 2004: reasoning and **ontology framework** for personalized learning on the Semantic Web

ontologies – domain, user, observation (interaction), presentation

Jovanović et al., 2006: **dynamic assembly** of personalized learning content on the Semantic Web

ontologies – content structure, content type (pedagogical role), learning path, domain, user model

Your Approach?

Which type of knowledge you want to specify and use?

How do you want to author it?

How to you want to represent it?

Summary & Conclusion

Koper, 2005: *the notation must make it possible to **identify, isolate, de-contextualize, and exchange** useful parts of a learning design so as to stimulate their **reuse** in other contexts*

Various ways of knowledge representation for learning resources

Issue: reusability and adaptivity

Challenge: representation of various types of knowledge and their interaction when generating concrete instances dynamically

Interoperability demands – between systems & between models/layers

Standards are not harmonized

Semantic Web is used as mediator